

Scotland's Rural College

## Food waste and losses in primary production: qualitative insights from horticulture

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*Published in:*  
Resources, Conservation and Recycling

*DOI:*  
[10.1016/j.resconrec.2017.07.042](https://doi.org/10.1016/j.resconrec.2017.07.042)

First published: 25/08/2017

*Document Version*  
Peer reviewed version

[Link to publication](#)

### *Citation for pulished version (APA):*

Beausang, C., Hall, C., & Toma, L. (2017). Food waste and losses in primary production: qualitative insights from horticulture. *Resources, Conservation and Recycling*, 126, 177 - 185.  
<https://doi.org/10.1016/j.resconrec.2017.07.042>

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# FOOD WASTE AND LOSSES IN PRIMARY PRODUCTION: QUALITATIVE INSIGHTS FROM HORTICULTURE

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## ABSTRACT

Food waste is recognised as being one of the major global challenges in achieving a sustainable future. Currently very little is known about how much food is wasted in primary production. This study uses a qualitative approach to examine farmers' views on food waste and losses occurring on soft fruit and vegetable farms. Semi-structured interviews were conducted with 12 fruit and vegetable farmers in Scotland to gain information about 1) farmers' attitudes to food waste, 2) how much food waste is generated on farms, 3) what are the causes of food waste, 4) what happens to the waste, and 5) what strategies can be used to reduce food waste on farms and add value to how waste is used. Thematic analysis was employed to analyse data from the interviews. This study revealed that farmers do not consider food waste to be an issue of primary concern and perceive food waste to be an intrinsic part of farming. Farmers do not routinely record waste and have difficulty in providing estimates for food waste and losses. Many of the causes of food waste identified in this study are due to factors further along the food supply chain, including cosmetic specifications by retailers, and a lack of processing facilities. Farmers expressed an interest in adding value to how food waste is used on their farms, but identified several barriers in relation to using food waste for energy production through anaerobic digestion.

**Keywords:** Food waste, primary production, horticulture, farmers, interviews, Scotland

## 1. INTRODUCTION

Food waste is recognised as a major global challenge in achieving a sustainable future. The most widely cited figure for global food waste and losses comes from a study by the Food and Agricultural Organisation (FAO) which estimated that one-third (by weight) of all food produced in the world in 2009 was lost or wasted (FAO, 2011). Food waste and losses can occur at each stage of the food supply chain (FSC), in primary production, processing, retail and consumption. The terms food loss and food waste are used either in tandem or separately in the literature (FAO, 2011; Franke et al. 2016). Generally, food loss is referred to at the earlier stages of the FSC, in production and processing (FAO, 2011; Kummu et al. 2012; Parfitt et al. 2010). The term food waste is generally applied at the later stage of the FSC in retail and final consumption. It is often associated with "wasteful behaviour" and a conscious decision to throw away food (FAO, 2011; Kummu et al. 2012; Parfitt et al. 2010). However, a distinction between wasteful behaviour and other reasons for food losses can be difficult to perform (Beretta et al. 2013). Accordingly, to depict food lost/wasted at all

stages of the FSC starting with primary production, we employ them in a similar fashion in this paper.

Generally, food waste and losses refers to plants and animals produced for human consumption but not ultimately consumed by people (Lipinski et al. 2013). This excludes materials for “non-food” purposes such as crops for biofuels (FAO, 2011). The point at which material becomes ‘food’ is when it is ready for harvest or slaughter, which means yield losses due to weather events or diseases are often excluded (Lipinski et al. 2013). When a commodity intended for human food consumption is directed to a non-food use such as animal feed, bioenergy or disposal in landfill, it is often considered as food waste (Beretta et al. 2013; FAO, 2011; Lipinski et al. 2013). However, food that was intended to be consumed by people but is instead diverted to animal feed may be excluded from the food waste definition, as the animals remain part of the human food chain (Fusions, 2016).

Quantifying food waste and losses in primary production is difficult as the sector has not been investigated to the same extent as other stages of the FSC (Fusions, 2016). The sector is also very heterogeneous with regards to what it produces, and consequently waste levels vary. Classifying food waste is more difficult earlier in the FSC when dealing with unprocessed products such as crops and livestock (Fusions, 2016). In Europe, it is estimated that as much as one-third of all food waste occurs in primary production (Bräutigam et al. 2014; European Parliament, 2013). Fruit and vegetables, along with roots and tubers, have the highest wastage rates of any food (FAO, 2011). Losses in developed countries mainly occur in agricultural production (FAO, 2011). Waste is also significant at the end of the FSC, due to unpredictability of demand and high perishability of fruits and vegetables (Beretta et al. 2013). In the UK estimates of waste for fruit and vegetables in primary production range from 1-30 percent (Farming Online, 2015; Tesco, 2014; WRAP, 2011).

## 1.1. CAUSES OF FOOD WASTE AND LOSSES IN PRIMARY PRODUCTION

Pre-harvest conditions and actions in the field can lead to losses later in the FSC, due to differences in the quality at harvest and during subsequent shelf-life (CFS, 2014). For fruit and vegetables, agronomic practices during the field stage greatly contribute to the product’s visual and nutritional quality (CFS, 2014). Pre-harvest factors that affect post-harvest losses include choice of crop variety and agronomic practices such as pest/ disease management and fertilisation (CFS, 2014). Poor harvest scheduling along with careless handling of produce contribute to food waste and losses along the FSC (CFS, 2014). Produce can be lost at harvest because mechanised harvesters cannot retrieve the entire item or because machines cannot discriminate between immature and ripe

produce (Kantor et al. 1997). Often these losses are viewed as an acceptable trade-off between field efficiency (i.e. lower production costs and faster operation) and increased yields (Kantor et al. 1997).

Many farmers sell their produce through “contract farming”; where products of defined quality and specification are sold to a particular retailer or food manufacturer (European Parliament, 2013). Contract farming may lead to farmers producing surpluses on purpose to ensure they do not undersupply their customers due to unforeseeable circumstances such as extreme weather or pest infestation. As a result, farmers may produce greater quantities than needed, even in “average” conditions, which may not reach market (FAO, 2011). In the UK, it has been estimated that contractual penalties, product take-back clauses, and poor demand forecasting can lead to 10 percent overproduction and high levels of wastage in the FSC (DEFRA, 2007; Parfitt et al. 2010).

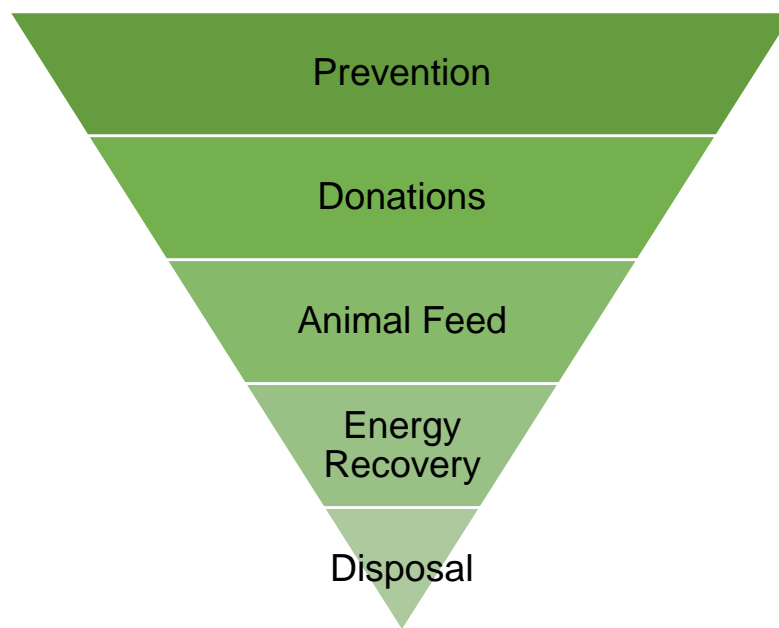
Promotions by retailers are seen as a useful tool for managing waste by clearing ‘gluts’ (Terry et al. 2013) and increasing sales of fruit and vegetables near the limit of their shelf-life (Mena and Whithead, 2008). However, it has been suggested by some producers that promotions were previously based on crop availability during peak harvest, but now are based on factors such as the number of products that are on promotion at any one time (Terry et al. 2013). Furthermore, some retailers cannot turn promotions on quickly enough to respond to surpluses (WRAP, 2011).

Cosmetic standards set by retailers have long been criticised as a major cause of food waste in developed countries (FAO, 2011; Göbel et al. 2015; WRAP, 2011). Specifications by retailers are mainly based on visual appearance: size, colour and shape, and freedom from defects (e.g. bruising, blemishes). If produce does not meet strict quality standards, it may be rejected by retailers at the farm gate (Bond et al. 2013; Stuart, 2009). For vegetables, cosmetic standards were identified as the main cause of food waste which resulted in farmers in Germany wasting a large proportion of their crop (Göbel et al., 2015). Cosmetic standards were also found to be a major cause of waste for potato in Scotland (Krzynowek and Hawkins, 2015).

## 1.2. MANAGING FOOD WASTE AND LOSSES

The management options for food losses and waste can be ranked according to the waste hierarchy (Papargyropoulou et al. 2014), shown in Figure 1. Research suggests that the environmental choice of waste management system from a life cycle perspective follows the food waste pyramid in many cases (Eriksson and Spångberg, 2017; Laurent et al., 2013). Prevention of food waste and losses is the most favourable option in the food waste pyramid. It includes avoiding surplus food generation

throughout food production and consumption, as well as preventing avoidable food waste generation throughout the FSC (Papargyropoulou et al. 2014). Priority is also given to donations to people in need, although this is limited by the fact that food waste can only be donated to charity if it is still fit for human consumption (Papargyropoulou et al., 2014). The least favourable options include disposal, i.e. end-of-life treatment without valorisation. However, since each waste management system is dependent on a local context, the waste hierarchy must still be seen as a rough generalisation (Eriksson et al., 2015).



**Figure 1:** The Food Waste Pyramid (adapted from Eriksson et al., 2015 and Papargyropoulou et al. 2014).

### 1.3. USING QUALITATIVE RESEARCH TO UNDERSTAND FOOD WASTE

As nobody intends to waste food, individual and outer circumstances and behaviour lead to the wastage of food (Schneider, 2008). Frequently, studies on food waste focus on the amount of waste arising and not the reasons why waste occurs (Heikkilä et al. 2016). Furthermore, much of the research addressing food waste uses methodologies that involve participants being given closed-ended questions, followed by a series of possible responses (Graham-Rowe et al. 2014). Such methodologies have limitations as they impose responses on the participant without allowing them to give their own perspective on a particular matter (Graham-Rowe et al. 2014).

Qualitative methods, such as interviews and focus groups, are a useful tool in research, as they can provide more opportunity for in-depth understanding than quantitative methods, allowing the

researcher to examine complex issues without imposing limitations (Graham-Rowe et al. 2014; Williams, 2007). The goal of qualitative research is the “development of concepts which help us to understand social phenomena in natural (rather than experimental) settings, giving due emphasis to the meanings, experiences and views of the participants” (Pope and Mays, 1995, p. 43). Furthermore, qualitative research is critical to explore new research questions prior to undertaking quantitative research (Bryman, 2006; Newenhouse and Schmit, 2000).

Qualitative research approaches have been successfully used to investigate food waste at the later stages of the FSC - in retail (Heikkilä et al. 2016; Mena et al. 2011) and consumption (Graham-Rowe et al. 2014; Hoek et al. 2017; Ofei et al. 2014; Sirieix et al. 2017). However, qualitative research examining food waste in primary production is relatively scarce, particularly looking at farmer attitudes to food waste. Farmers are the key stakeholders for reducing waste and losses in primary production, and any strategy must take their attitudes and views on food waste into account.

This study examines the farmers’ views on food waste occurring on soft fruit and vegetables farms. Given the open-ended nature of the research questions proposed, a qualitative approach was used in this study to gain a better understanding of the food waste and losses in horticulture by carrying out semi-structured interviews with soft fruit and vegetable farmers. The interviews took place in Scotland in June 2016. The causes of food waste, as well as usage and disposal routes, were assessed.

## 2. MATERIALS AND METHODS

### 2.1. SAMPLING PROCEDURE AND RECRUITMENT

A preliminary list of potential interviewees was generated by an online search using keywords such as “fruit farm” and “vegetable producer Scotland”. Flyers were distributed at the Royal Highland Show (Scotland's annual farming and countryside showcase), containing relevant information and contact details for the study. Social media was also utilised to generate awareness of the project and seek additional interviewees. Following initial interviews, snowball sampling techniques were used to recruit additional participants (FLW Standard, 2016).

## 2.2. INTERVIEW PROCEDURE

Interviews were semi-structured with 19 questions. The opening part of the interview included questions on information such as size of the farm and crops grown. The second half of the interview contained open-ended questions. These provided insights into the issues surrounding food waste, including the destinations for waste fruit and vegetables. Farmers were asked how they themselves would define food waste and losses; therefore we did not impose a specific definition in the script. The interview script was pre-tested with colleagues to ensure the wording of the questions was clear, and no additional changes were necessary<sup>2</sup>. The interviews were carried out in June 2016. The length of the interviews ranged from 15 to 40 minutes. All interviews were transcribed verbatim with the aid of F4 Transkript software (2016).

## 2.3. PARTICIPANTS

A total of twelve people were interviewed for this study. The majority of interviews were concentrated in Fife, where Scottish horticultural production predominates (Scottish Government, 2016). Two of the participants were operations managers for vegetable co-operatives, where up to 40 farmers grow produce for the co-operatives on agreements. The remaining participants were managers of individual farms. Farm cropland area was used to distinguish between farm sizes in this study. A small farm was thus defined as a farm of less than 50 hectares cultivated with fruit and/or vegetables. Farms were considered to be medium sized if they were between 50 and 200 hectares. Farms were considered to be large if they were greater than 200 hectares. These farm size categories were assigned ex-post. Small and medium sized farms generally marketed their produce directly to consumers, through farm shops and 'pick your own' on-farm enterprises. Large farms generally sold their produce to major retailers, either directly or indirectly via distributors for processing, packaging and distribution. An overview of the farm characteristics where interviews were conducted is given in Table 1.

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<sup>2</sup> The interview script is available from the corresponding author upon request.

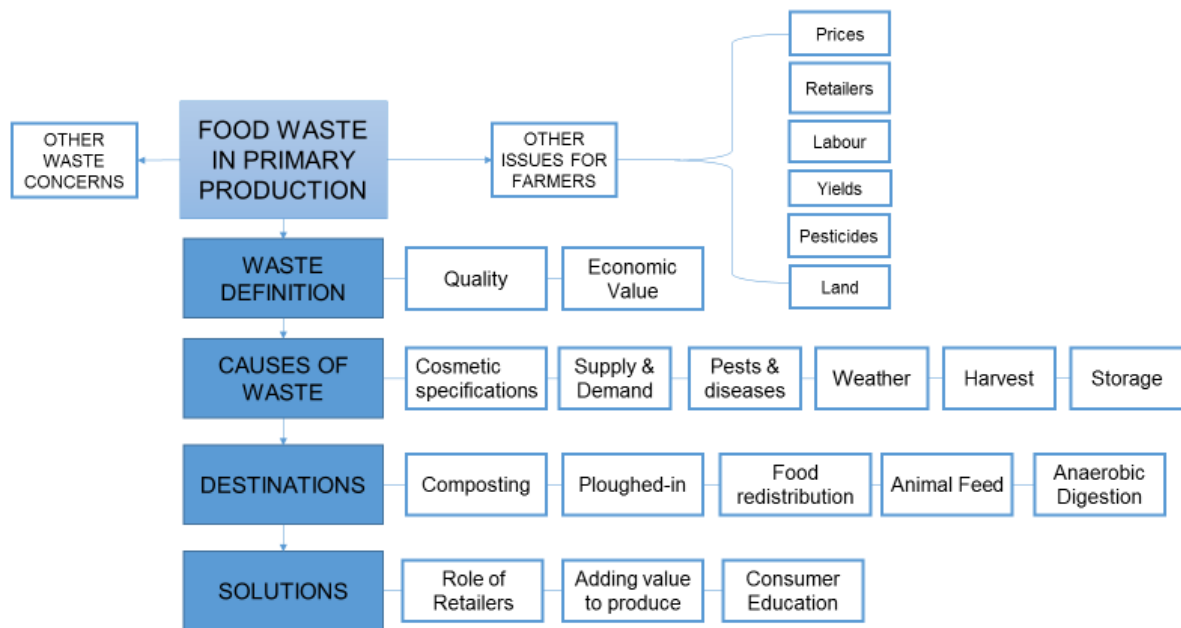


Farm no.	Type	Size (ha)	Classification	Market
1	Fruit	4	Small	Pick your own, wholesaler
2	Fruit	12	Small	Pick your own
3	Fruit	100	Medium	Farm shop, pick your own
4	Fruit	242	Large	Retailers
5	Fruit	243	Large	Retailers
6	Fruit & Veg	14	Small	Farm shop, local businesses
7	Fruit & Veg	400	Large	Retailers
8	Veg	20	Small	Farm shop
9	Veg	300	Large	Retailers
10	Veg	3500	Large	Retailers
11	Veg (Co-op)	1821	Large	Retailers
12	Veg (Co-op)	2500	Large	Retailers

**Table 1:** Overview of farm characteristics where interviews were conducted

## 2.4. THEMATIC ANALYSIS

The interview transcripts were organised and coded using NVivo 11 software (2015). Thematic analysis was the method used to identify the main themes in the data. A “theme” can be described as capturing something important in the data in relation to the research question, and representing some level of patterned response or meaning within the data set (Braun and Clarke, 2006). The procedure for thematic analysis used in this study was based on the methods described by Alhojailan (2012) and Braun and Clarke (2006). The first step was to become familiar with the data set through active reading, noting patterns in the data and ideas for coding in the process. This was followed by the generation of initial codes to make connections between different parts of the data. The codes were then sorted into relevant themes. Some themes were identified a priori based on the literature review and pre-existing knowledge, while other themes were identified inductively during the coding process. As the coding exercise progressed, no new themes emerged in later interviews, which suggested that saturation was likely reached for the topics discussed (Kalcic et al. 2014). The coding framework including the themes and sub-themes identified is illustrated in Figure 2. Key themes included the definition of waste, causes, destinations, and solutions.



**Figure 2:** Coding framework for thematic analysis; including themes and sub-themes.

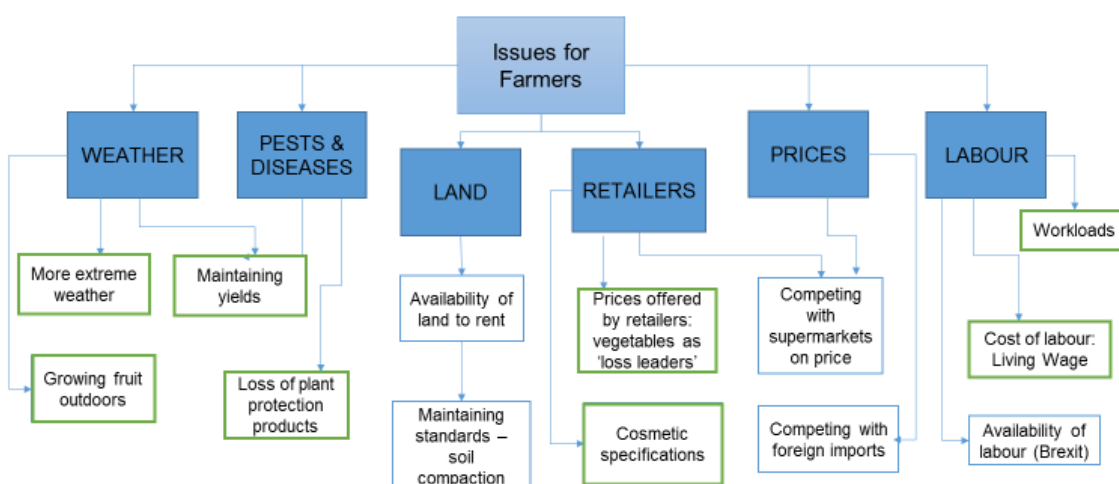
## 2.5. CAUSAL MAPPING

A causal map was used to examine the underlying causes of food waste in primary production. Causal maps are a type of cognitive map, which model the relationships between the different elements of a system (Scavarda et al. 2006). Causal maps can be used to focus attention on the root causes of a problem, to find critical control points and to manage risks (Scavarda et al. 2006). The causes of food waste and losses on farms were determined using the method described by Walker and Cox (2006). A statement (known as an undesirable effect or UDE) was made that described the problem relating to food waste e.g. “Wet or damp fruit does not keep”. Each UDE was then tested for clarity. When a list of 10 UDEs was completed, the next step was to search for a causal relationship between 2 UDEs, using an “if-then” logic, i.e. “IF cause THEN effect”. This process was continued until all UDEs were connected. This specific methodology was used to illustrate the links farmers described between the different causes of food waste and losses during primary production, as understanding the relationships between such causes will be crucial in any strategy for reducing food waste and losses.

### 3. RESULTS AND DISCUSSION

#### 3.1. FARMER ATTITUDES TO FOOD WASTE AND LOSSES

At the start of the interviews, interviewees were asked: “What are the major issues or challenges for you as a grower, now and in the future?”. This was to identify their main concerns and to provide a context for the research on food waste in primary production, in order to understand how important waste and losses are for soft fruit and vegetable farmers. The main issues identified are presented in Figure 3. No farmer specifically mentioned food waste as a key concern. However, many of the challenges that farmers did identify - weather, pests, diseases, the role of retailers, and labour costs - are directly relevant to the reasons why food waste occurs on farms. These are highlighted in green in Figure 3. As an example, farmers described the weather and pressures from pests and diseases as presenting challenges in maintaining yields, which in turn can lead to losses in the field. This research suggests that while yields and productivity are a concern, the term “food waste” may not immediately resonate with farmers as a priority issue.



**Figure 3:** Coding framework for the main issues outlined by interviewees. Note: the issues relevant to food waste are highlighted in green.

Farmers in this study shared the view that waste is an intrinsic part of agriculture. Farmers stated that while it was necessary to minimise waste (“to reduce it and reuse anything that we can”), waste and losses will always occur in the field. One farmer made a comparison of food waste at the primary production stage and further along the FSC, describing food waste on the farm as acceptable:

*“I suppose that waste during production is acceptable but further along the stages (of the food supply chain), there’s quite a lot of unacceptable food waste”.*

This view of food waste being part of agriculture and “acceptable” and useful may be linked to how food waste is dealt with. The farmers interviewed did not see “food waste” as a distinct problem if they can put it to some use on their farms e.g. compost, animal feed. One farmer with a small vegetable farm described that once they cut what is needed, the field is grazed by livestock, stating “anything that’s in the field still gets used”. They went on to say: “So we really don’t throw out any as such”. Another farmer said any fruit that does not get picked goes to the birds, or gets ploughed back in, saying “it’s almost like a green manure...and it does the ground some good...”. Primary production is quite unique in the FSC, as farmers are subjected to many factors which are outside of their control, such as weather conditions. This can mean that food waste and losses on farms are more difficult to avoid compared with later stages of the FSC, where waste may be caused by deliberate actions taken by people, and is therefore more avoidable (Franke et al. 2016).

In each interview, participants were asked how they defined waste. The responses provided can be categorised into two themes, with waste being defined either by the quality of produce, or based on economic value. In terms of quality, the definitions of waste provided were based on the premise that the produce was not suitable for the end user. The reasons given for this included produce being unsuitable for harvest or not meeting cosmetic specifications. A definition given by one farmer based on quality was as follows:

*“Waste is anything that doesn't fit into a specification or is not of good enough quality”.*

Farmers often specified the reasons why produce was not of sufficient quality when defining waste. When farmers described waste as produce that is not suitable for harvest, weather, pests and diseases were mentioned. When cosmetic specifications were included in the definition, discolouration and misshapes were mentioned.

In terms of economic value, farmers defined waste as produce that does not have a market, or produce that is not sold (or picked, in the case of ‘pick your own’ farms). An example of a definition of waste based on economic value was:

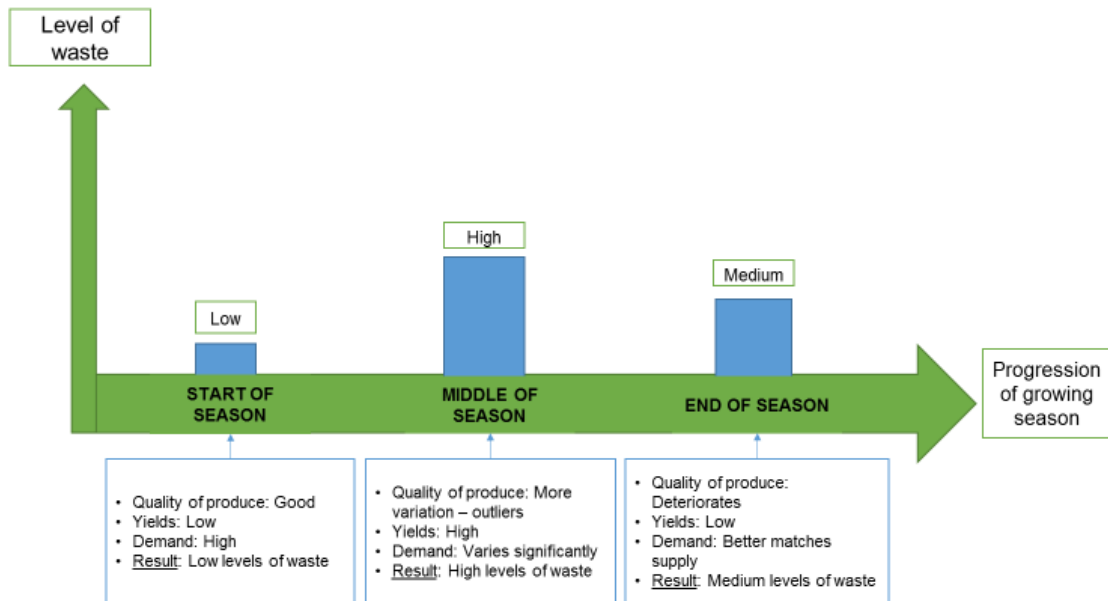
*“Most of it is produce that we're producing but can't sell... if we don't have a market for it, it's waste”.*

This research suggests that while yields and productivity are a concern, the phrase “food waste” may not immediately resonate with farmers as a priority issue. As farmers do not explicitly see food waste as a key concern, any possible approaches to reducing food waste and losses on farms should be phrased and framed in a context that is relevant to farmers e.g. in terms of economic losses.

In the literature, the most common point for estimating food waste and losses on farms is when crops are mature and ready to harvest (Franke et al. 2016). As a result, much of the waste from causes suggested by the farmers in this study, including weather, pests and diseases, would not be captured in the common methodologies of estimating food waste and losses, suggesting that waste levels may be even higher than the literature reports. Furthermore, agricultural production and post-harvest handling and storage are often treated as separate stages in the FSC (FAO, 2011), however both stages are relevant for estimating losses on-farm. For future studies on food waste and losses in primary production, it is crucial that the boundaries of this stage of the FSC are clearly defined and that when farmers are asked to provide data, there is clarity around definitions used.

### 3.2. ESTIMATES OF FOOD WASTE AND LOSSES IN PRIMARY PRODUCTION

In this study, farmers found it difficult to provide an estimate of waste on their farms, the majority interviewed said that it was not something that they recorded. As a result, farmers were guided to make an estimate of waste and losses in a typical year and in an extreme year. However, as one farmer said: “It's very difficult because we never have a typical year”. This was reiterated by another farmer who said: “I'd be lying I think if I gave you a number, it kind of varies year to year”. Originally it was intended to ask farmers to provide a breakdown of estimates across the causes of food waste and losses they identified. However, as farmers found it difficult to provide a figure even for overall losses, this distinction was not possible in this study. Furthermore, farmers described fluctuations in the amount of waste occurring within the season, as shown in Figure 4. This illustrates the complexity in trying to estimate food waste and crop losses in primary production, and shows how yields, demand and quality interact to generate different levels of waste throughout the season. The highest levels of waste occur in the middle of the season when yields are at their peak but quality and demand vary significantly.



**Figure 4:** Variation in levels of waste for fruit and vegetables across the growing season.

Interviewees from some of the small farms were unable to provide these estimates for waste and losses. When probed for the reasons for this, the participants stated that it was difficult to provide an estimate when it varied so much year-to-year, and it was not something they recorded. These smaller farms have greater flexibility with a number of outlets to sell their produce, including farm shops, and local businesses. In contrast, the large farms supplied a number of retailers through contract farming. As these farms have fewer outlets to direct their produce, and have to supply retailers with specified amounts, it was easier for such farmers to estimate the amount of waste arising on their farms.

The average amount of waste estimated to be generated annually for farms in this study is shown in Table 2. When farmers were asked how high waste levels may be in an ‘extreme’ year, they suggested that waste levels for vegetables in primary production may be as high as 50 percent (for carrots and lettuce). The estimated proportion of strawberry crop that does not go towards human consumption increased with farm size. In extreme cases, the highest level of waste for soft fruit was estimated to be 15 percent. Overall, when comparing fruit and vegetables, estimated levels of waste were much higher for vegetables than fruit. However, given the difficulty farmers had in providing estimates of waste, these figures should be interpreted with caution.

Crop	%
Carrots	30-50
Broccoli	20
Brussel sprouts	25
Swede	20
Lettuce	40-50
Strawberry: small farms	1
Strawberry: medium farms	5
Strawberry: large farms	5-15
Other soft fruit*	5

\* Raspberries, blueberries, cherries

**Table 2:** Estimates of waste and losses for fruit and vegetable farms as a percentage of production. Not all farms produced every type of fruit/vegetable included in the study; where one farm only produced a fruit/vegetable, the single estimate from the farmer is provided. When more than one farm produced the fruit or vegetable, the range of estimates given by farmers is provided.

The estimates of waste in this study; 20-50 percent for vegetables and 1-15 percent for soft fruit, were similar to figures reported in the literature. Estimates of waste for fruit and vegetables in primary production in the UK range from 1-30 percent (Farming Online, 2015; Tesco, 2014; WRAP, 2011). For strawberries, farmers in this study suggested that levels of waste were as low as 1 percent. This is lower than the figures reported in the literature, with studies suggesting that on-farm waste levels for strawberries range from 10 to 25 percent (Franke et al. 2016; Tesco, 2014). It is not clear whether the lower figures for soft fruit waste and losses in this study are due to farmers under-estimating their waste levels or due to the study sample. While every effort was taken to include a range of farms based on size, location and business model, this study cannot claim the sample is representative.

The insights gained from this study provide a useful basis for future quantitative research. Given the difficulties in obtaining reliable estimates for the levels of food waste and losses in agriculture, a quantitative study which examines food waste and losses over several years would be of value. To gain an understanding of food waste and losses in agriculture nationally, a study which requires the reporting of waste figures by farmers over a number of years may be a valid approach. This could be achieved by reporting through a national agricultural census or any other formal reporting that farmers are required to undertake at a national level.

### 3.3. CAUSES OF FOOD WASTE

The root causes of food waste and losses in primary production as identified by the interviewees were determined using a causal map, as described in section 2.5 and shown in Figure 5. The root causes of food waste and losses are highlighted in blue and include cosmetic specifications, weather, pests and diseases, harvest, storage, and supply and demand. Losses due to pests and diseases represented a common reason farmers gave for why crops are wasted on their farms; however, such losses are commonly recorded as 'yield losses', as opposed to crops that are wasted. This is distinguished in the map using a dashed blue line. While many of the causes of food waste identified in this study have previously been outlined in the literature, the causal map produced from this study goes a step further by illustrating the connections between the causes, which will now be described.

#### 3.3.1. PESTS AND DISEASES

Pests and diseases were frequently cited as a cause of yield losses in the field. For vegetables Diamondback moth, root fly, and damage by pigeons were major concerns. For soft fruit birds, mice, and slugs were named as major pests. Botrytis and mildew were the main diseases that farmers mentioned. Farmers stated that some damage by pests and diseases is purely cosmetic. One farmer used the example of root fly (*Delia radicum*) on swede, which causes damage to the skin. However, the skin of the swede is not eaten (by humans); it is peeled before cooking. Hence the crop is wasted on a cosmetic basis.

#### 3.3.2. COSMETIC SPECIFICATIONS

Cosmetic specifications were cited by all farmers that were interviewed as being a key cause of food waste. Participants indicated that retailers provide specification sheets to which they must adhere, detailing the size, shape and colour of produce required. Farmers described the size range that retailers specify for crops such as broccoli and strawberry. For example, one farmer indicated that the size range permitted by retailers for strawberries is 25-45mm in length and if the product falls outside of the specified size bands, it will not be accepted by retailers. Farmers in this study suggested that more can be done to relax cosmetic specifications for fruit and vegetables. Independent research into consumer attitudes to cosmetic specifications might be helpful to inform farmer – retailer discussions on this issue. A number of farmers suggested that education could be a way to increase consumer awareness around cosmetic specifications. Campaigns about the benefits



of “ugly” fruit and vegetables are one possible approach, which was used successfully by Intermarché, the third largest supermarket in France (NPR, 2014).

### 3.3.3. OVERPRODUCTION

Overproduction is cited in the literature as a major cause of food waste and losses on farms (DEFRA, 2007; Parfitt et al. 2010). However, the majority of farmers interviewed stated that they did not overproduce, and many farmers said that this was because relationships with retailers have improved in recent times. Farmers said that they are now able to discuss issues of shortages with retailers, and many felt it was no longer necessary to overproduce in case of undersupplying their customers. Crop surpluses are reduced as a result, which means less food goes to waste. The results of this study suggest that overproduction may now be a less important issue than previously thought, though this requires more detailed exploration.

### 3.3.4. WEATHER

In the literature, when weather is being considered as a cause of food waste it is generally in the context of crop losses in the field (Bond et al. 2013). However, the farmers interviewed for this study reported a number of additional reasons; it can cause cosmetic damage to crops, reduce storage times and greatly influence both the supply and demand of produce. Poor weather conditions can cause damage to crops, rendering them unfit for sale. Farmers described how hailstorms and heavy rain can damage leafy brassica crops and cause cherries to crack. One farmer described the problem of oedema or cell breakdown in Brussels sprouts, which occurs when poor weather is followed by a sudden burst of warm, sunny conditions, resulting in a black spot on the sprout. However, as this blemish is only on the outside and would be trimmed in preparation, it is purely a cosmetic issue and therefore should not need to lead to food waste.

### 3.3.5. SUPPLY AND DEMAND

Retailers are often blamed for providing unpredictable orders and poor timing of in store promotions (Parfitt et al. 2010). Many farmers in this study who sell their produce to major retailers said that orders were unpredictable and described how changing weather conditions influence a) how much produce they have and b) the demand for their produce. Farmers described how they experience major dips in orders for “traditional veg” such as broccoli, Brussel sprouts, leeks and cabbage when the weather is sunny. Weather is also a critical factor in determining demand for soft fruit. If retailers see that weekends will be wet, orders will be smaller on the Wednesday or Thursday. Poor weather is also a problem for ‘pick your own’ enterprises, as wet weather results in

fewer people visiting the farm. The impact of weather on the balance of supply and demand for both farmers and retailers has not been well documented in the literature and warrants further research. Farmers suggested that they can forecast when they will have gluts of produce, and food waste could be reduced if promotions for supermarkets were better timed. Many farmers suggested that it is not economically viable to harvest produce when there is a lack of demand. In such instances, greater efforts should be made to redistribute surplus produce to food charities through 'gleaning'.

### 3.3.6. HARVEST

Physical damage can occur when crops are harvested both manually and mechanically. For example, broccoli heads can dehydrate if they are not handled correctly when being removed from the field, leading to increased waste. When crops are harvested mechanically, wet weather can cause higher levels of damage in the field. Inefficient manual harvesting by new pickers is also an issue, particularly for soft fruit. Farmers described that when new workers start on the farm, they may pick strawberries without the stalk. As this is part of the specifications set by retailers, such strawberries are wasted, even though the stalk is never eaten and it is purely a presentational issue. However, most farmers stated that such issues with labour are short term, and do not take long to rectify.

### 3.3.7. STORAGE AND PROCESSING FACILITIES

The participants from larger farms generally had cold stores to hold their produce after harvest. The storage times for fresh fruit and vegetables vary greatly, and this has an impact on the amount of waste that is produced. The storage times for different produce outlined by farmers are shown in Table 3. Farmers indicated that soft fruit, lettuce and Brussels sprouts are not held for any significant period of time. Broccoli, leeks and swede are held for longer periods.

Crop	Storage time
Strawberries	24 hours
Lettuce	24 hours
Brussels sprouts	24 hours
Broccoli	10 days
Leeks	1 month
Swede	4 months

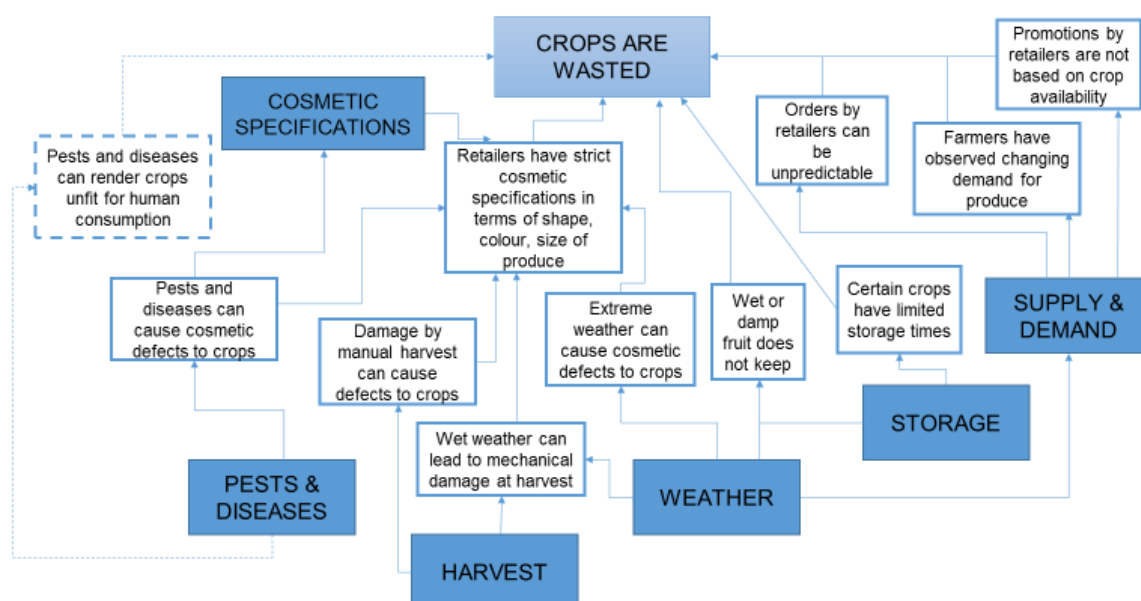
**Table 3:** Average storage times for crops post- harvest

However, storage times are affected by other factors. Many farmers mentioned that harvesting fruit in wet conditions was a major problem, as damp fruit will hold for a shorter period, thus reducing the length of time the fruit can be stored once harvested. Farmers reported that a lack of processing and freezing facilities were also factors leading to food waste and losses on their farms. The operations manager from one vegetable co-operative said that freezing broccoli gave them greater flexibility and helped to reduce waste. As there are limited freezing facilities in the country, the broccoli is sent to England, and cannot be frozen until the pea harvest in Lincolnshire is over, usually the 2<sup>nd</sup> week of August. This ultimately has implications for the shelf life of produce and associated waste. Investing in processing and freezing facilities could be a valuable way to further reduce food waste along the FSC. However, the environmental impact of such changes to food waste management should be assessed to ensure the net reduction in food waste and losses outweighs potential increased energy consumption from freezing facilities.

### 3.3.8. CHANGING CONSUMER DEMAND

Changing consumer tastes and demand are not frequently cited as an issue for food waste and losses in the literature. However, farmers in this study described how they have seen changing demands for their produce over the years for crops such as swede, broccoli, strawberries and gooseberries, which have influenced the levels of food waste on their farms. They suggested that changing consumer tastes may be related to an ageing population. Farmers stated that they had lost a lot of older customers that used to buy products such as jam berries and swede. Farmers also stated that culture was changing, with more people shopping in supermarkets. One farmer blamed the year-round availability of strawberries for declining sales in their farm shop, stating that previously people would only buy strawberries when they were in season. One solution may be for farmers to diversify the crops that they grow. However, because farmers have grown their crops for numerous years, they have built up expertise, along with having the specific machinery and equipment required. As a result, farmers may show a reluctance to change their ways, and this may be the reason why they blame consumers for such losses. Farmers in this study said there is a need for 'added value products' to find alternative uses for their produce and to overcome changing consumer demands. Farmers suggested that broccoli, leeks, and swede are crops that would benefit from the creation of products with added value. Creating products with added value should be seen as an opportunity by retailers to reduce food waste on their shelves, as well as helping to reduce food waste on farms. Research into the links between changing population structure and product

preferences would be of value to establish if consumer tastes and demand are a more important factor in food waste and losses in primary production than the literature currently indicates.



**Figure 5:** Causal map for waste in primary production

### 3.4. MANAGEMENT OF FOOD WASTE AND LOSSES IN HORTICULTURE

In each interview farmers were asked what they do with the crop that they do not sell for human consumption. The destinations outlined by farmers included animal feed, composting, ploughing back into the soil, land spreading, redistribution, and anaerobic digestion (AD).

For vegetable farms, the most commonly mentioned use for wasted produce was as animal feed. When asked why the waste was used in this way, farmers said that feed was in high demand. It also appeared to be the most convenient and cheapest option, as other farmers would remove waste crop for their livestock at no extra cost. In the case of soft fruit farms, composting the waste crop on-farm was the most commonly cited use. Farmers also stated they would leave crops that were ready for harvest in the field, or plough them back into the soil when there was no demand. Food redistribution was mentioned by one farmer from a small fruit and vegetable farm who said that at certain times he would be contacted by a gleaning initiative who collected the unharvested crop for redistribution.

Pest and disease pressures are a major factor in determining how the waste crop is used. One strawberry farmer said that you could not have fruit lying around, as it could be a “pool for pests”,

and specifically mentioned the fruit fly *Drosophila*, saying the fruit had to be buried or destroyed. One vegetable farmer stated that if produce was dumped, it had to be spread out thinly on the field that it came from to avoid causing problems with diseases.

Farmers said that they had considered the use of AD for their waste crop. One farmer who produces a large amount of vegetables said he had planning permission for an anaerobic digester, but had not yet built it as he cannot get grid connection. Another vegetable farmer stated because many of their crops were “such a watery-based product”, rye grass would have to be grown as an additional feed source for the AD plant. The manager of one vegetable co-operative stated that one of their growers has an AD plant, but as most of the waste was “water”, it got ploughed back-in. They went on to say: “We are looking at trying to optimise these biofuel plants more, and having one of our growers have one, but again we don't have a consistent supply to rely on that”. One soft fruit farmer said that an AD plant was opening soon nearby, and it was interested in taking some of their waste. However, they went on to say that transporting the waste to the site would be a problem.

While AD may not be appropriate for small and medium sized farms individually, there may be potential for co-operative style arrangements, where several different farm types send their waste to a central AD site. It is likely that incentives would be required to encourage farmers to avail of such facilities, as many farmers said that their waste crop is used for livestock feed, and will be removed from their farms by neighbouring farmers at no extra cost.

Many of the current destinations for food waste and losses on the farms in this study are based on the lower tiers of the food waste pyramid (Figure 1), including energy recovery and animal feed. Priority should be given to food waste management options at the top of the pyramid, including prevention and redistribution.

## 4. IMPLICATIONS AND FUTURE RESEARCH

This study represents one of few attempts in qualitative literature to examine farmer attitudes to food waste in primary production. This type of exploratory research is essential for successful interventions to reduce food waste, as farmers are key stakeholders for reducing food waste and losses, and any strategy to address food waste in primary production must have their full support. This study has shown that farmers view food waste and losses in the context of the whole farm business. As a result, a ‘whole farm approach’ is the best way to address horticultural food waste. Using a qualitative approach has some limitations. While the sample of farmers interviewed enabled the root causes of food waste and the relationships between causes to be identified, their relative

importance could not be quantified. The findings from this study can inform future research with larger samples to derive additional evidence on why food is wasted in primary production, and how it can be avoided or valorised. Such future research could also be designed to determine the proportion of produce that is lost to specific causes and to determine how much is used on-farm and off-farm in the destinations described.

## 5. CONCLUSION

This study has highlighted a number of areas for addressing food waste on soft fruit and vegetable farms. Prevention of food waste and losses should be a priority. Relaxing cosmetic specifications for produce and investing in processing facilities are two strategies by which this can be addressed. Any attempts to reduce food waste in primary production will require the involvement of actors further along the FSC, including retailers. Where food waste cannot be prevented there should be additional initiatives to increase short-chain re-distribution, for example to food bank charities and pop-up food waste caterers. When food waste and losses on farms are unavoidable and cannot be re-distributed, efforts should be made to extract the maximum value from that waste. This can be achieved by diverting waste produce to animal feed and anaerobic digestion. Such measures will be a positive step to ensure that food from fruit and vegetables farms will make its way along the FSC as intended, from 'farm to fork', without being wasted.

## ACKNOWLEDGEMENTS

This research was funded by the Scottish Government Rural Affairs, Food and the Environment Strategic Research Programme 2016-2021 Theme 3 RD3.1.4 'Preventing food waste'. We would like to thank the interviewees for giving their time to the study.

Declaration of Interest: The authors declare that they have no conflict of interest.

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